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56571

PCT/IL2006/000453
09 MAY 2006

PA 1452876

THE UNITED STATES OF AMERICA

TO ALL TO WHOM THESE PRESENTS SHALL COME:

UNITED STATES DEPARTMENT OF COMMERCE

United States Patent and Trademark Office

April 19, 2006

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APPLICATION NUMBER: ***60/673,664***
FILING DATE: ***April 20, 2005***

THE COUNTRY CODE AND NUMBER OF YOUR PRIORITY APPLICATION, TO BE USED FOR FILING ABROAD UNDER THE PARIS CONVENTION, IS ***US60/673,664***

By Authority of the
Under Secretary of Commerce for Intellectual Property
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PROVISIONAL APPLICATION FOR PATENT COVER SHEET

This is a request for filing a PROVISIONAL APPLICATION FOR PATENT under 37 CFR 1.53(c).

INVENTOR(S)

Given Name (first and middle [if any])	Family Name or Surname	Residence (City and either State or Foreign Country)
Alex	WINOKUR	108 Hatishbi Street Haifa Israel

[ ] *Additional inventors are being named on the ___separately numbered sheets attached hereto.*

TITLE OF THE INVENTION (280 characters max)

A METHOD AND AN APPARATUS FOR SYNCHRONOUS MIRRORED DATA PROTECTION AT ANY DISTANCE

Direct all correspondence to: **CORRESPONDENCE ADDRESS**

[ ] Customer Number [ ] → *Place Customer Number Bar Code Label here*

OR *Type Customer Number here*

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ENCLOSED APPLICATION PARTS (*check all that apply*)

[X] Specification (includes drawings) *Number of Pages* 7 [ ] CD(s), Number

[ ] Drawing(s) *Number of sheets* [ ] Other (specify)

[ ] Application Data Sheet. See 37 CFR 1.76

METHOD OF PAYMENT OF FILING FEES FOR THIS PROVISIONAL APPLICATION FOR PATENT (check one)

[X] Applicant claims small entity status. See 37 CFR 1.27.

[X] A check or money order is enclosed to cover the filing fees

[X] The Commissioner is hereby authorized to charge filing fees or credit any overpayment to Deposit Account Number: 01-0035

FILING FEE AMOUNT ($): $100.00

[ ] Payment by credit card. Form PTO-2038 is attached.

The invention was made by an agency of the United States Government or under a contract with an agency of the United States Government.

[X] No.

[ ] Yes, the name of the U.S. Government agency and the Government contract number are: _____

Respectfully submitted,

SIGNATURE Jay S. Cinamon

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Date April 20, 2005

REGISTRATION NO. (*if appropriate*) 24,156

Docket Number: 206,961

USE ONLY FOR FILING A PROVISIONAL APPLICATION FOR PATENT

STATEMENT OF FILING BY EXPRESS MAIL 37 C.F.R. § 1.10

This correspondence is being deposit with the United States Postal Service on April 20, 2005 in an envelope as "Express Mail Post Office to Addressee" Mailing Label Number ER 842 050 849 US addressed to the Commissioner for Patents P.O. Box 1450, Alexandria, VA 22313-1450.

1. Invention Name

A Method and an Apparatus for Synchronous Mirrored Data Protection at Any Distance

2. Inventors

Alex Winokur

3. Background

One of the more effective methods to protect data is by maintaining a mirror image of the data at a secondary location. For the purpose of this invention we shall assume that the data to be protected is maintained on Direct Access Storage Devices (DASD) i.e. disks both in the primary and the secondary sites, however without loss of generality the data can be maintained in computer memory, magnetic tapes, or any other device that can storage data.

Thus a typical data mirroring is achieved by taking every write operation to the primary DASD where the data is originally to be stored and replicating it to the secondary DASD where the mirrored data is maintained. A typical non-mirrored write operation consists of the following steps:

1. An application running on an application server (a server based application) issues a write command to the DASD.
2. Once the DASD completes executing the write command it issues an acknowledge to the server based application notifying it of a successful execution of the write command
3. The write command is considered successfully completed only after the server based application receives the acknowledge from the DASD

When the written data is to be protected using mirroring, a write operation is augmented by additional steps to implement the mirroring protection depending on the mirroring strategy.

For synchronous mirroring the steps are as following:

1. A server based application issues a write command to the mirroring application.
2. The mirroring application issues this a write command to the primary DASD and to the secondary DASD.
3. Once both DASDs complete executing the write command they issue an acknowledge to the mirroring application notifying it of a successful execution of the write command
4. Only after receiving both acknowledgments the mirroring application issues an acknowledge to the server based application
5. The write command is considered successfully completed only after the server based application receives the acknowledgement from the mirroring application.

For asynchronous mirroring the steps look as following:

1. A server based application issues a write command to the mirroring application.
2. The mirroring application issues a write command to the primary DASD

3. The mirroring application stores the write command in its internal memory.
4. Once the primary DASDs completes executing the write command it issues an acknowledge to the mirroring application notifying it of a successful execution of the write command
5. When the mirroring application receives the acknowledgments from the primary DASD the mirroring application issues an acknowledge to the server based application
6. The write command is considered successfully completed only after the server based application receives the acknowledge from the mirroring application

Asynchronously with steps 2 to 5 and at some point of time following step 3 above the mirroring application does the following

2.1. The mirroring application issues the write command to the secondary DASD based on the data stored in its internal memory (see step 3 above)
2.2. The mirroring application receives an acknowledgment from the secondary DASD
2.3. The mirroring application deletes from its internal memory the write command

Note 1: The mirroring application can run on the primary DASD, the application server, or on a computing appliance which is located between the application server and the primary DASD.

Note 2: Typically the mirroring application is transparent to the server based application. I.e. the server based application is not aware that it issues its write operations to a mirroring application rather than to the primary DASD itself.

Unlike asynchronous mirroring, the synchronous mirroring guaranties that if the write operation completed successfully at the server based application, the written data is secured at both primary and secondary DASD location. Asynchronous mirroring guaranties a successful completion at the primary DASD only. On the other hand the latency of a write operation in the asynchronous scenario is smaller than for the synchronous mirroring because the mirroring application does not need to delay sending an acknowledgment to the application till it receives the acknowledgement from both the primary and the remote DASD. This delay is proportional to the distance between the primary location and the secondary (mirrored) location and it is of a considerable magnitude if the secondary DASD resides at a remote distance from the primary DASD.

A disaster scenario is a situation where the entire data center loses it ability to function and all the data it maintains is (at least temporarily) lost. Disasters occur as a result terrorist attacks, earthquakes, floods, major power outages atc. To protect data in case of a disaster, a replica of the data has to be maintained at a remote location (of typically more then 200 miles) using mirroring technology. Neither of the above described mirroring strategies provides adequate data protection solution in case of a disaster. If synchronous mirroring is to be used than the secondary site has to be in close vicinity to the primary site. If asynchronous mirroring is to be used then in case of the disaster the data associated with the last write operations will be lost depending on when the mirroring application issues a write operation to the remote location (steps 2.1.to step 2.3. above) i.e. all data for which an acknowledge was received from

a primary DASD, but was not received yet from the remote DASD is assumed to be lost.

In this invention we provide a solution which enables to protect data in case of data disaster at any distance without loosing the data of the last write operations prior to the disaster event.

4. Problem Definition

A synchronous mirroring schema guaranties that in case of a disaster no data is lost. However to obtain good performance synchronous mirroring can be used over short distances (local mirroring) between the primary and the secondary sites. Asynchronous mirroring on the other hand, can not guarantee no lose of data associated with the last write operations prior to a disaster. However using asynchronous mirroring one can maintain a mirror site at any distance (remote mirror).

In this invention we propose an apparatus and a method to enable a full and complete data protection at a secondary site in case of a disaster event at the primary site, regardless of the distance between the two sites, with performance characteristics of a local mirror.

5. The proposed solution

The proposed solution consists of four components:

1. The protection machine. A general purpose computing machine like Linux server for example.
2. A specialized "black box" apparatus.
3. A recovery machine
4. A set of mirroring algorithms.

5.1 The Protection Machine

The protection machine is any general purpose server that can run any program. It consists of a CPU, memory, internal busses, storage, communication ports, and in particular communication ports of the type over which application servers communicate their I/O traffic with the DASD. These ports will typically be Fibre channel ports or IP ports. In addition the protection machine contains a number of USB or USB like standard ports. These ports are categorized by providing high data bandwidth to the devices they connect to and by providing also electric power to these devices.

In this implementation the protection machine will connect in band on the I/O communication lines through the I/O communication ports between the application server and the mirroring application assumed to run on the primary (local) DASD as described in figure 1. In other implementations the protection machine can be connected between the machine running the mirroring application, close to that

machine, and the remote DASD. In addition the protection machine will connect through its USB ports to the black box apparatus.

5.2 Black Box Apparatus

The black box apparatus consists of the following components

1. Flash memory or any other persistent memory similar to a disk on key device

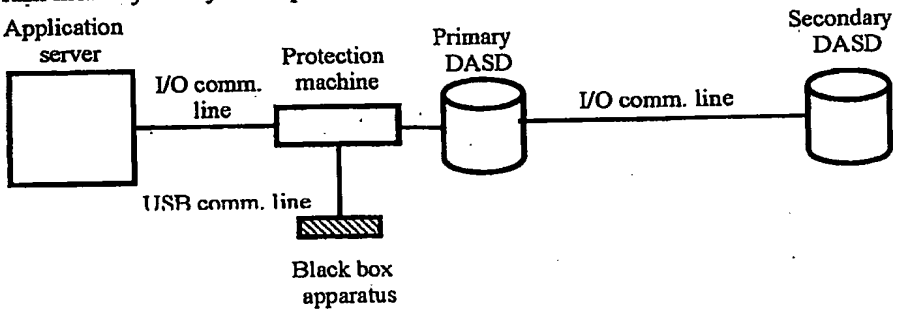

Figure 1

2. A rechargeable battery powered by the USB port.
3. A homing device powered by the rechargeable battery.
4. A reinforced enclosure, similar to the technology used in airplanes.

The black box apparatus is designed to survive any catastrophic disaster like explosion, fire and floods, protecting all the data stored in the flash memory similar to an airplane's black box. When it experiences a power outage, the homing device starts transmitting a radio signal to ease the location of the apparatus (in case an explosion causing the demolition of the site for example). In addition the design of the box is such that the persistent memory modules within the box can be easily removed and placed in another black box similar to the method they can be removed from a digital camera's for example. This feature is needed for the case where the USB port itself is damaged in a disaster.

5.3 The Recovery Machine

The recovery machine is any general purpose server similar to the protection machine and of similar configuration.

In this implementation it is located at the remote location connects to the remote DASD.

5.4 The Algorithms

The algorithms are based on the assumption that all write operations issued by the application server to the primary DASD pass through or are at least visible by the protection machine. The algorithms consists of the following two separate phases

1. The data protect algorithm
2. The disaster recovery algorithm

Algorithms Overview

A full and complete data protection to a secondary site located at any distance is achieved by executing asynchronous mirror to the remote site of all date to be protected. To guarantee that no data is lost in the event of a disaster, all data which was not yet secured to the remote site is maintained locally in the black box apparatus. Once this data is written by the mirroring application to the remote location it can be discarded from the black box apparatus. The black apparatus and its memory is design to withstand any disaster thus protecting the data it hosts. Since data is kept in the black box device only until it is written to the remote site the required memory needed to host this data within the black box is of a limited size.

The memory of the black box apparatus is managed by protection machine. Every write operation from the application server to the mirroring application is also forwarded to the protection machine. This is accomplished in one of the following three methods:

1. The protection machine is connected between the application server and the mirroring application as in figure 1, thus all write operations pass through it.
2. The protection machine tabs on the line between the application server and the mirroring application
3. The protection machine connects to the mirroring application and the mirroring application forward every write operation to the protection machine.

Once accepted by the protection machine, the protection machine store the write operation, its associated data, and some additional information (see next section) to the black box memory.

The protection machine is also responsible for freeing memory space in the black box device in one of the three following possible methods:

1. Whenever a new data is to be stored and the memory is full, the protection machine will free memory by discarding from it the data associated with least resent write operation. In this implementation we assume that the black box memory is large enough to guarantee that every write operation is always written to the remote DASD before it is discarded from the black box memory.
2. Whenever the mirroring application receives a positive acknowledgment from the remote DASD signaling the data associated with some write operation was successfully stored there, the mirroring application also forward this acknowledgement to the protection machine. Based on this acknowledgment the protection machine will identify which write operation was successfully completed on both the primary and remote DASD, and will discard its corresponding data from the black box memory.

In another implementation the black box apparatus connects directly to the same machine running the mirroring application. In this case no protection machine is required. The mirroring application will use the black box apparatus memory directly as its internal memory where it stores the write operations in step 3 of the asynchronous mirror algorithm on page 1.

When disaster occurs, the black box apparatus is located, if necessary, with the aid of a homing device based on the radio signal it transmits. It can then be shipped to a

remote location and connected to the recovery machine. The recovery machine will read the data associated with each write operation from the black box memory in the order in which the write data was initially stored and update the remote DASD.

Note: There is no need to keep track which updates where already written to the remote DASD by the mirroring application since applying the same update more than once does not impact the consistency of the data.
Note: If the USB connector itself is damaged it is possible to dismantled the box extract its flash memory and install it in another box.

In another implementation the black box apparatus can connect to any machine which is connected by communication line to the recovery machine and transmit the content of its memory encrypted, using the communication lines through Internet for example. The unique program needed to transmit the data to the remote location will itself be stored in the black box memory, so for this particular implementation, except for having Internet access and USB port no additional requirements need to be imposed on that general purpose machine.

Data Structures

The major data structure maintained by the algorithms presented here is the data associated with each write operation which is stored within the memory of the black box apparatus. For each write operation the following data elements are maintained:

```
WRITE_DATA
{
    Communication address of the application server sending the write operation
    Communication address of the primary DASD
    Time stamp of receiving the write operation
    All parameters of the write operation including the storage address of where
        the data is to be placed on primary storage
    The data to be written by this write operation
}
```

The Data Protect Algorithm

In this implementation this algorithm runs on the protection machine. It operates as following:

```
Data Protect
For every write operation received from the application server Do
{
    Allocate buffer frame within the black box apparatus and return BufferFrame
                a pointer to this buffer
    Write WRITE_DATA to buffer pointed by BufferFrame
}
```

The buffers within the black box device are being managed by the data protect algorithm running in the protection box as a circular buffer as following:

```
Allocate Buffer
If free buffer entries within the buffer exists Then
{
    Allocate free entry buffer
    Return BufferFrame pointer to this buffer
```

Else
{
Locate buffer entry *X* with data which resides in the buffer for the longest period of time
Discard the data from buffer entry *X*
Allocate free buffer entry *X*
Return pointer *BufferFrame* to buffer frame *X*
}

Data Recover
For data of every write operation stored in the black box apparatus memory ***Do***
{
Read each *WRITE_DATA* entry in the order in which it was initially stored
Based on the storage address, write the data to the appropriate remote DASD location
}

3. *Claims*

1. A black box apparatus which
    a. Hosts transient write data until it is written to remote site
    b. Connects easily to any computing system
    c. Its memory is managed by a computing system it connects too
    d. Host all data protection/data recovery programs
    e. The above programs can be downloaded to any computing system
    f. Does not need external power supply
    g. Can survive any catastrophic disaster
    h. Its internal memory can be removed and installed in another black box apparatus without loosing the data it stores
    i. All data and programs stored in it will survive a catastrophic disaster
    j. Equipped with a homing device
2. A set of algorithms which utilizes the black box apparatus
    a. The algorithms can either run on a separate box or on the same box as the mirroring application
    b. Protect data which was not replicated yet to a remote site using asynchronous mirror scheme in the black box apparatus
    c. Inducing performance impact on the native write operations similar to that introduces by asynchronous mirror
    d. In a case of a disaster updating off-line the remote mirror DASD with all updates which were not yet transmitted to the remote DASD.
3. A protection machine which connect to the black box and can serve multiple application sever by connecting to all of them by a switch

From the INTERNATIONAL BUREAU

PCT

NOTIFICATION CONCERNING
SUBMISSION OR TRANSMITTAL
OF PRIORITY DOCUMENT

(PCT Administrative Instructions, Section 411)

To:

SANFORD T. COLB & CO.
P.O. Box 2273
76122 Rehovot
ISRAËL

Date of mailing *(day/month/year)* 30 May 2006 (30.05.2006)	
Applicant's or agent's file reference 56571	IMPORTANT NOTIFICATION
International application No. PCT/IL2006/000453	International filing date *(day/month/year)* 10 April 2006 (10.04.2006)
International publication date *(day/month/year)* **Not yet published**	Priority date *(day/month/year)* 20 April 2005 (20.04.2005)
Applicant AXXANA (ISRAEL) LTD. et al	

1. By means of this Form, which replaces any previously issued notification concerning submission or transmittal of priority documents, the applicant is hereby notified of the date of receipt by the International Bureau of the priority document(s) relating to all earlier application(s) whose priority is claimed. Unless otherwise indicated by the letters "NR", in the right-hand column or by an asterisk appearing next to a date of receipt, the priority document concerned was submitted or transmitted to the International Bureau in compliance with Rule 17.1(a) or (b).

2. *(If applicable)* The **letters "NR"** appearing in the right-hand column denote **a priority document which, on the date of mailing of this Form, had not yet been received by the International Bureau** under Rule 17.1(a) or (b). Where, under Rule 17.1(a), the priority document must be submitted by the applicant to the receiving Office or the International Bureau, but the applicant fails to submit the priority document within the applicable time limit under that Rule, **the attention of the applicant is directed** to Rule 17.1(c) which provides that no designated Office may disregard the priority claim concerned before giving the applicant an opportunity, upon entry into the national phase, to furnish the priority document within a time limit which is reasonable under the circumstances.

3. *(If applicable)***An asterisk (*)** appearing next to a date of receipt, in the right-hand column, denotes **a priority document submitted or transmitted to the International Bureau but not in compliance with Rule 17.1(a) or (b)** (the priority document was received after the time limit prescribed in Rule 17.1(a) or the request to prepare and transmit the priority document was submitted to the receiving Office after the applicable time limit under Rule 17.1(b)). Even though the priority document was not furnished in compliance with Rule 17.1(a) or (b), the International Bureau will nevertheless transmit a copy of the document to the designated Offices, for their consideration. In case such a copy is not accepted by the designated Office as the priority document, Rule 17.1(c) provides that no designated Office may disregard the priority claim concerned before giving the applicant an opportunity, upon entry into the national phase, to furnish the priority document within a time limit which is reasonable under the circumstances.

Priority date	Priority application No.	Country or regional Office or PCT receiving Office	Date of receipt of priority document
20 April 2005 (20.04.2005)	60/673,664	US	24 May 2006 (24.05.2006)
20 October 2005 (20.10.2005)	60/729,112	US	NR

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56571

PCT REQUEST

Original (for **SUBMISSION**)

0	**For receiving Office use only**	
0-1	International Application No.	PCT/IL2006/000453
0-2	International Filing Date	10 APR 2006 (10.04.2006)
0-3	Name of receiving Office and "PCT International Application"	ISRAEL PATENT OFFICE PCT International Application
0-4	**Form PCT/RO/101 PCT Request**	
0-4-1	Prepared Using	PCT-SAFE [EASY mode] Version 3.51.005.180 MT/FOP 20060401/0.20.4rc.2.7
0-5	**Petition**	
	The undersigned requests that the present international application be processed according to the Patent Cooperation Treaty	
0-6	**Receiving Office (specified by the applicant)**	Israel Patent Office (RO/IL)
0-7	**Applicant's or agent's file reference**	56571
I	***Title of invention***	REMOTE DATA MIRRORING SYSTEM
II	**Applicant**	
II-1	This person is	applicant only
II-2	Applicant for	all designated States except US
II-4	Name	AXXANA (ISRAEL) LTD.
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II-6	State of nationality	IL
II-7	State of residence	IL
III-1	**Applicant and/or Inventor**	
III-1-1	This person is	applicant and inventor
III-1-2	Applicant for	US only
III-1-4	Name (LAST, First)	WINOKUR, Alex
III-1-5	Address	108a Hatishbi Street 34521 Haifa Israel
III-1-6	State of nationality	IL
III-1-7	State of residence	IL

PCT REQUEST

Original (for **SUBMISSION**)

IV-1	**Agent or common representative; or address for correspondence** The person identified below is hereby/ has been appointed to act on behalf of the applicant(s) before the competent International Authorities as:	agent
IV-1-1	Name	SANFORD T. COLB & CO.
IV-1-2	Address	P.O. Box 2273 76122 Rehovot Israel
IV-1-3	Telephone No.	972-8-9455122
IV-1-4	Facsimile No.	972-8-9454556
IV-1-5	e-mail	colbpat@stc.co.il
IV-2	**Additional agent(s)**	additional agent(s) with same address as first named agent
IV-2-1	Name(s)	COLB,Sanford, T.; DYM,Susie; FEIGELSON,Daniel; GINSBURG,Hershel; KLIGLER,Daniel; METZGER,Gershon; SECEMSKI,Ephraim; SHAULSKY,Eitan
V	**DESIGNATIONS**	
V-1	**The filing of this request constitutes under Rule 4.9(a), the designation of all Contracting States bound by the PCT on the international filing date, for the grant of every kind of protection available and, where applicable, for the grant of both regional and national patents.**	
VI-1	**Priority claim of earlier national application**	
VI-1-1	Filing date	20 April 2005 (20.04.2005)
VI-1-2	Number	60/673,664
VI-1-3	Country	US
VI-2	**Priority claim of earlier national application**	
VI-2-1	Filing date	20 October 2005 (20.10.2005)
VI-2-2	Number	60/729,112
VI-2-3	Country	US
VII-1	**International Searching Authority Chosen**	United States Patent and Trademark Office (USPTO) (ISA/US)

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PCT REQUEST

Original (for **SUBMISSION**)

VIII	Declarations	Number of declarations	
VIII-1	Declaration as to the identity of the inventor	-	
VIII-2	Declaration as to the applicant's entitlement, as at the international filing date, to apply for and be granted a patent	-	
VIII-3	Declaration as to the applicant's entitlement, as at the international filing date, to claim the priority of the earlier application	-	
VIII-4	Declaration of inventorship (only for the purposes of the designation of the United States of America)	-	
VIII-5	Declaration as to non-prejudicial disclosures or exceptions to lack of novelty	-	
IX	**Check list**	number of sheets	electronic file(s) attached
IX-1	Request (including declaration sheets)	4	✓
IX-2	Description	21	-
IX-3	Claims	7	-
IX-4	Abstract	1	✓
IX-5	Drawings	6	-
IX-7	TOTAL	39	
	Accompanying Items	paper document(s) attached	electronic file(s) attached
IX-8	Fee calculation sheet	✓	-
IX-17	PCT-SAFE physical media	-	✓
IX-19	**Figure of the drawings which should accompany the abstract**	1	
IX-20	**Language of filing of the international application**	English	
X-1	**Signature of applicant, agent or common representative**		
X-1-1	Name (LAST, First)	COLB, Sanford, T.	
X-1-2	Name of signatory		
X-1-3	Capacity		

56571

PCT REQUEST

Original (for **SUBMISSION**)

FOR RECEIVING OFFICE USE ONLY

10-1	Date of actual receipt of the purported international application	10 APR 2006 (10.04.2006)
10-2	Drawings:	
10-2-1	Received	✓
10-2-2	*Not received*	
10-3	Corrected date of actual receipt due to later but timely received papers or drawings completing the purported international application	
10-4	Date of timely receipt of the required corrections under PCT Article 11(2)	
10-5	International Searching Authority	ISA/US
10-6	Transmittal of search copy delayed until search fee is paid	✓

FOR INTERNATIONAL BUREAU USE ONLY

11-1	Date of receipt of the record copy by the International Bureau	